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ENGELMANN SPRUCE BEETLE INFESTATION ON THE
NATIONAL FORESTS OF THE WESTERN SLOPE OF COLORADO
1946

By

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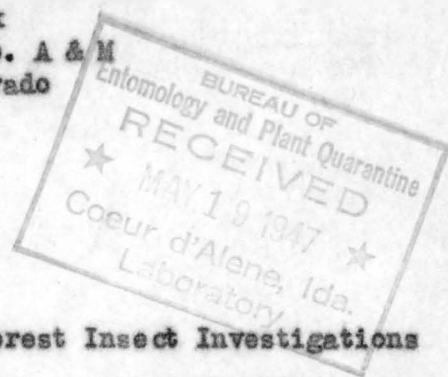
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SUBJECT-

INDEX NO.-

UNITED STATES DEPARTMENT OF AGRICULTURE
~~Agricultural Research Administration~~
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

~~WASHINGTON, D.C.~~
308 Agric. Bldg., Colo. A & M
Fort Collins, Colorado
May 1, 1947



To: Dr. F. C. Craighead, In Charge, Forest Insect Investigations
From: N. D. Wygant, Entomologist in Charge, Fort Collins, Colorado
Subject: Engelmann Spruce Beetle Infestation of the National Forests of
the Western Slope of Colorado 1946 - A Report by T. T. Terrell

Enclosed are two copies of the above report which covers the results of the Engelmann spruce beetle surveys financed by the U. S. Forest Service. As a result of this survey, we have what is believed to be an adequate picture of the situation today.

You will note that the total estimate of spruce losses through 1946 is placed at 3 billion board feet. This is 1 billion board feet less than the estimate made last fall from observation and a preliminary analysis of the data. The discrepancy is due to the early overestimation of the losses on the San Juan and Montezuma Forests and to the application of a blanket loss figure to the White River Forest that was too high. While the infestations on the San Juan and Montezuma and serious they do not cover as large an area as the early observations indicated. On the White River Forest there are some units where the infestation has not reached the final stages.

We believe the Engelmann spruce beetle situation to be much brighter than a year ago. The infestations did not spread appreciably, no new centers were found, and a decided decrease occurred on several Forests. However, the possibility of a mass flight of beetles from the White River Forest still exists. There is not sufficient green host material left to absorb the flight in 1947. For this reason we believe it necessary to examine the spruce areas around the White River infestation after the 1947 attack period. Although the infestations on the Montezuma, San Juan, Holy Cross and Routt Forests showed a decline in 1946, such areas should be covered again in 1947 to insure against a flare-up and to complete the case histories.

A very important finding of the survey is that all the mature spruce type carries a rather high endemic infestation, presumably as a normal condition. This situation plus the high brood production of the species accounts for the rapid increase following a blowdown. Also, much evidence in the

epidemiology of this insect points toward an extremely important role by the woodpeckers. On the basis of our experience with the current outbreaks, one is inclined to conclude that blowdowns are responsible for outbreaks and woodpeckers responsible for their decline. However, it probably is not as simple as that. Normal or better than normal precipitation plus good ring growth since 1939 largely rules out the possibility of drought being an important factor. While the overmature stands may be more susceptible, the younger stands are not immune to outbreaks. This is exemplified by the Grand Mesa outbreak that started in a stand composed largely of trees about 150 years old except for a few scattered trees or groups of trees. These very old trees are the few that escaped the severe outbreak on the Grand Mesa Forest about 75 years ago.

As a result of the biology work of Dr. Massey on the White River Forest, we have a good working knowledge of the life history of the insect. The next important phases of the problem are: (1) Improvement of treating methods through the use of new insecticides; (2) epidemiology; and (3) development of silvicultural methods of control.

The epidemiology is extremely important and we should be doing more along this line. The woodpeckers now appear to be the most important single factor in the control of beetle populations. We should know more about their habits, their population fluctuations, their force exerted upon the beetle population, and a simple method of measuring their population. It is conceivable that artificial control may be necessary only when woodpecker populations are low and then only in sufficient amount to balance the beetle population with the woodpecker population. Woodpecker studies should be started this season on the White River Forest while there is still a very high beetle population and continued through the downward trend and into a normal endemic period. Then to complete the program, investigations should be carried through a rising infestation.

So long as Engelmann spruce is managed for saw timber and there are few roads into the type, there seems to be little hope of developing a silvicultural method of control that will in itself prevent beetle outbreaks. The salvage group selection system and clear cutting in alternate strips being studied by the Rocky Mountain Forest and Range Experiment Station has shown the least loss from windfall. Such methods will reduce blowdown to the minimum, but there is no insurance against a general blowdown such as the one in 1939. Terrell's survey shows that localized blowdowns in virgin timber are of common occurrence, any one of which could start an outbreak if natural control factors are low. The salvage group selection system of cutting in which 60 percent of the merchantable volume of the stand is removed is entomologically sound. Fifty percent of the volume is removed in the groups and the remaining 10 percent from between the groups. The 10 percent comprise the trees that appear to lack sufficient vigor to live until the next harvest 30 to 40 years hence. Observations indicate that these are the trees that maintain a high endemic infestation. However, the real obstacle in the path of a silvicultural method of control is the 40 percent or more of the stands that may never be operable and into which

3-Dr. F. C. Craighead-5/1/47

no roads will be built. Such stands will always carry a high endemic infestation that can soon develop into epidemic proportions with a blowdown or a low cycle in natural control factors and spread to managed stands. However, it is encouraging to note that outbreaks in the current epidemic have not spread appreciably beyond the areas of heavy blowdown. The influence of these inoperable stands upon managed stands is still a matter of conjecture.

What we need to prevent an occurrence of a disaster similar to the one on the White River Forest is a cheaper method of treating infested trees, a working knowledge of the natural control factors, more access roads, and an accurate detection of incipient outbreaks. With the new insecticides we have a good chance to develop vastly improved treating methods. A study of the natural control factors, particularly the woodpeckers, cannot be carried out without additional funds unless the Fish and Wildlife Service can carry the work on their funds. The forest roads will be built at a rate determined by need. In the placement and building of new roads, their value for insect control should be considered along with other uses.

Copies of Mr. Terrell's report along with this letter are being distributed as indicated below.

W. R. W.

cc: Dr. Craighead (2)
Keen
Evenden
Regional Forester R-2 (2)
White River
Routt
Grand Mesa
Uncompahgre
San Juan

ENGELMANN SPRUCE BEETLE INFESTATION ON THE
NATIONAL FORESTS OF THE WESTERN SLOPE OF COLORADO
1946

A report on the Engelmann spruce beetle surveys of 1946 by
the Division of Forest Insect Investigations, Bureau of
Entomology and Plant Quarantine in cooperation with the U. S.
Forest Service.

Submitted by.

T. T. Ferrell
T. T. Ferrell
Entomologist

Approved by:

Neel D. Wygant
Entomologist in Charge

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~~Agricultural Research Administration~~
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

~~WASHINGTON, D. C.~~

308 Agric. Bldg., Colo. A & M
Fort Collins, Colorado
April 16, 1947

ENGELMANN SPRUCE BEETLE INFESTATION
ON THE NATIONAL FORESTS OF THE
WESTERN SLOPE OF COLORADO
1946

Introduction

For the third consecutive year a reconnaissance was made of the Engelmann spruce beetle infestation in the National Forests of the Western Slope in Colorado. These surveys were made under the direction of the Bureau of Entomology and Plant Quarantine with funds provided by the U. S. Forest Service.

The following report will give the results of the survey of 1946 and will attempt to summarize the losses to the Engelmann spruce stands since the start of the outbreak of the Engelmann spruce beetle, (Dendroctonus engelmanni Hopk.) about 1940 - an outbreak that has destroyed over 2½ billion board feet of timber.

Dating this infestation as starting in 1940 is open to question. However, the rapid build-up in 1942, 1943, and 1944 indicate a starting point a year or two previous to 1942. Evidence is also available that the infestation is closely associated with blow-downs. This leads us to believe that the wide-spread blow-down of June 1939 provided a store of host material over large areas which permitted an immediate rise in the normal Engelmann spruce beetle population.

As to why such a rapid build-up occurred, the following observation is offered. Apparently, mature Engelmann spruce stands are subject to a high degree of normal infestation. During the past three years sample plots have been taken in a number of stands that, from all appearances, were infested only to a normal extent. The infestation in these areas varied from .1 to .4 percent of the trees. Although this figure does not appear to be important it assumes greater significance when one applies it to a stand which ordinarily runs from 80 to 110 stems per acre. There is then, a normal infestation of approximately one infested tree for every 20 acres of stand. These insect killed trees are apparent throughout the forest. They are the snags that have come to be regarded as a natural part of the stand. It is obvious, then, that there is always a substantial population of beetles on the forest. Normally, it is thought that

these insects are held in check by their natural predators, the woodpeckers and predacious insects. However, of these natural predators it seems certain that the woodpeckers are by far the most important. Woodpeckers feed on the brood in standing trees throughout the year. Often during the winter they strip the bark off to the snow line. Emergence of insects from such trees would be largely the survivors from below the snow. Under these circumstances a very high percentage of the potential of the Engelmann spruce beetle is destroyed.

It may readily be seen that with the insect brood in windfalls, where they are protected by snow, the story would be different. Consider the many thousands of windfalls left by the blow-down of 1939 and the stage is set for the outbreak that followed.

A very extensive reconnaissance undertaken late in 1944 was not intensive enough to provide much detailed information nor to establish definitely the areas infested. However, data taken and observations made did show that on the White River National Forest alone over one billion board feet of timber had been killed, and that the infestation was increasing rapidly. It was also established that areas on the Grand Mesa, Gunnison, Holy Cross, Routt and Uncompagre National Forests were infested.

It was possible to obtain more intensive data during 1945 when the Forest Service provided funds for a small survey crew. Surveys were again made on the White River, Grand Mesa, Holy Cross and Gunnison National Forests. Some additional data were obtained on the Montezuma, San Juan, Routt, and Rio Grande National Forests. At the close of the 1945 season it was possible to describe the limits of the infestation with fair accuracy.

With a better understanding of the area to be covered, and with the advantage of two years of experience on the problem, we were able to organize two, two-man crews during 1946 and to spread the work more evenly throughout the infested areas. Although the area surveyed was huge and the sample small, enough data were obtained to show the trend of the infestation and to give an idea of the losses that have occurred.

A summary of the data obtained are given for each forest surveyed, as well as any observations that are thought to have a bearing on the problem. Small scale maps of each forest are included showing, roughly, the areas discussed. At the reports end, are some photographs showing typical terrain and Engelmann spruce type. It is also felt advisable to give a short description of the methods of taking the data and the compilation of it into the following tables.

In sampling large stands with only a few men we tried to spread the samples as much as possible while not losing too much in travel time. All but absolutely essential data were eliminated so that the maximum output per man-day might be accomplished. To obtain data relative to the infestation per acre, 10th acre plots were taken every two to four chains on compass lines. The data recorded on the plot consisted of all Engelmann spruce within the plots by 2 inch diameter classes, from 7 inches up. Insect attacked and dead trees were recorded by years, as 1946, 1945. However, because of the difficulty of accurately dating trees older than 1945 kill, all other trees killed within recent years

were grouped into the five year period 1940-1944. From the tenth acre plots data were secured which showed the relationship between green and insect killed trees on an acreage basis. Diameters of each were converted to basal areas and a comparison is made showing the percentages in basal areas. This figure is closely comparable to volume and it is the figure used in estimating the percentage of volume lost. The average tree diameter was obtained from the basal areas. This figure represents the average tree and is not the average diameter.

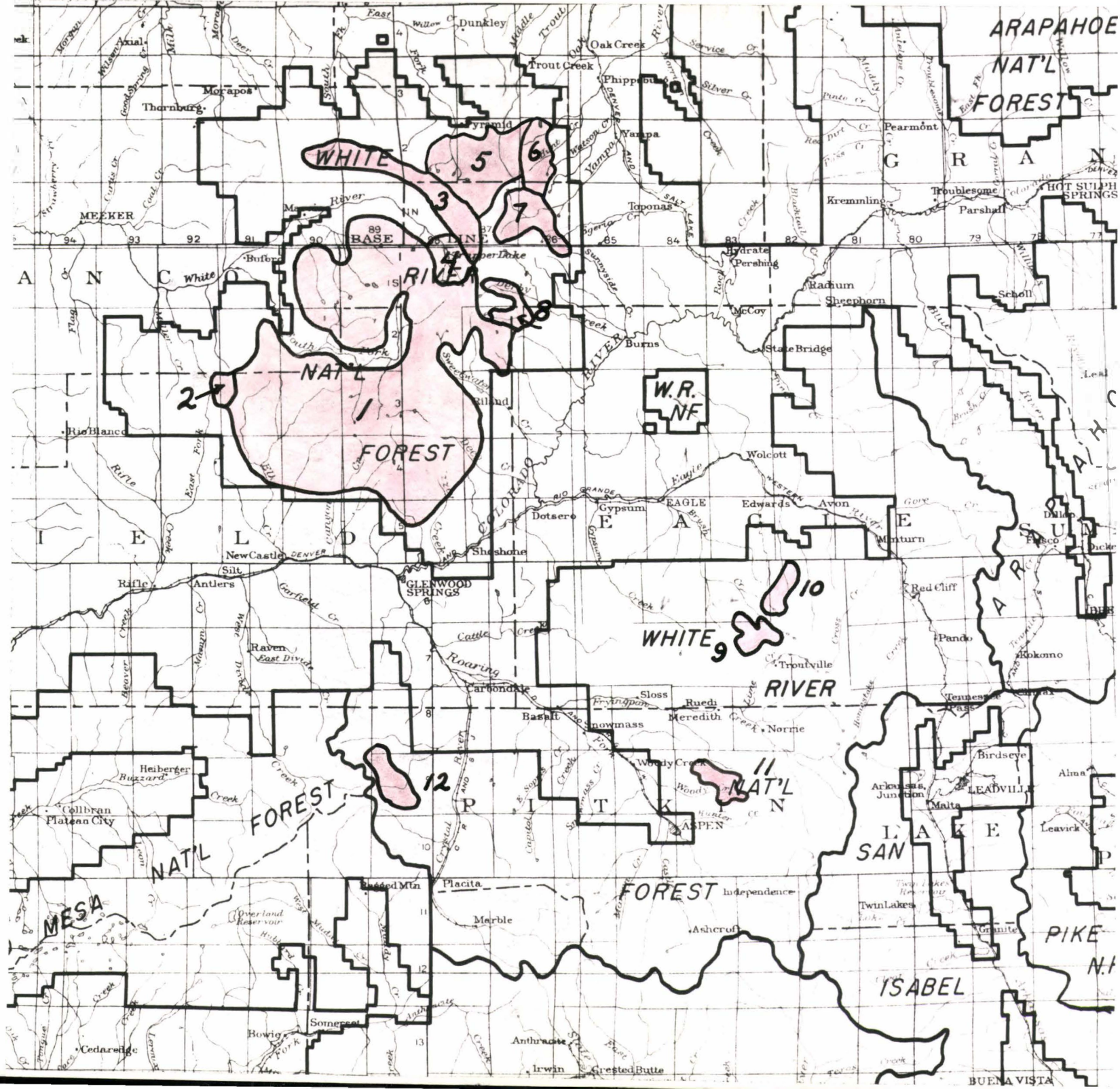
In order to spread the samples over the areas surveyed, strings of ten plots were usually taken at half mile intervals. Between the strings of plots, as a means of utilizing travel time and to supplement plot data, Engelmann spruce were examined and recorded in the same classifications as in the plots but diameters were not recorded. From this data plus the trees recorded in the plots the percentages of stems killed were obtained.

WHITE RIVER NATIONAL FOREST

1. Flat Top areas
2. Triangle Park
3. Pagoda Peak - Ripple Creek Pass
4. Trappers Lake
5. Lost Lakes - Sand Lakes
6. Croshaw Lake - Moody Creek
7. Bear River
8. Darby Creek

HOLY CROSS ADDITION

9. Iron Ridge
10. New York Mountain
11. Woody Creek
12. Thompson Creeks



WHITE RIVER NATIONAL FOREST

Because of varying intensities of the infestation, the White River National Forest is divided into five parts.

Engelmann Spruce Beetle Infestation Flat Top Area, T. 1N, 1,2,3,4, & 5 S., R. 87,88,89,90, & 91 W White River National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter of Av. Tree. In.
Killed 1940-1944	26.0	26.1	41.9	22
" 1945	30.8	34.8	34.4	18
" 1946	31.7	32.5	21.0	14
Residual Stand	7.9	6.6	2.7	11

Basis of Data: 230 Plots, 8195 Exam. trees

The above table is representative of the timbered area throughout the Flat Top or Mesa type of the forest. Samples were taken in the vicinity of Deep Lake, East of Blair Mountain, West of Blair Mountain, and in the heads of several drainages as far west as Triangle Park. Previous sampling indicates a similar condition to exist in the Cline Top and in several townships between the South Fork and North Fork of the White River. Altogether there are 12 townships in which the infestation has destroyed practically all of the Engelmann spruce. The photographs taken from Blair Mountain show a large part of this area.

Throughout the infested area there is some variation in the intensity of the infestation. However, it seems irrelevant to state that in the Cline Top to Blair Mountain area, 99.3 percent of the basal area has been killed while east and north of Blair Mountain 96.5 percent has been killed. There is noticeably less infestation southeast of Deep Lake in the Crane Park area, but even here a very high percentage of the stand is either dead or dying.

From Triangle Park west to the end of the Engelmann spruce type the infestation is comparatively light. The data for the following table were taken between Triangle Park and Muddy Spring.

Engelmann Spruce Beetle Infestation Triangle Park Area, T. 3 S., R. 91,92 W. White River N.F.

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	4.5	5.6	9.7	21
" 1945	2.0	2.3	3.2	20
" 1946	.8	1.0	1.6	20
Residual Stand	73.0	91.1	85.5	15

Basis of Data: 60 Plots

Logging of infested trees for the past several years is felt to be instrumental in holding the infestation down in this area. Apparently the infestation did not develop as rapidly here as it did farther east. Perhaps a lesser number of windfalls and more widely scattered stands contributed to the condition.

During the spring of 1946, 450 infested trees were treated as an experiment to determine the possibilities of control. Apparently the control measures were effective in reducing the Engelmann spruce beetle population where there is still an abundance of host material.

Engelmann Spruce Beetle Infestation
Trappers Lake and Vicinity, T. 1 N. & 1 S., R. 87, & 88 W.
White River National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	4.0	5.3	8.4	18
" 1945	5.0	6.4	9.4	17
" 1946	15.0	19.5	24.6	16
Residual Stand	52.8	68.8	57.6	13
Basis of Data: 300 Plots				

The Trappers Lake area is comparatively small. It includes approximately 5 sections of mixed lodgepole pine and Engelmann spruce in the basin around the lake and down as far as Lake-of-the-Woods. Apparently the Engelmann spruce in this area is less susceptible to insect attack than the type at higher elevations. At least, the infestation is not as marked here as on the adjacent higher areas. However, as the data indicates, a heavy increase occurred in the number of infested trees during the past year.

Of special interest was the discovery of the Engelmann spruce beetle attacking lodgepole pine in the Trappers Lake area. First reported by the Forest Supervisor, this infestation was thought to be the Black Hills beetle attacking trees in the vicinity of the Forest Inn Resort. However, during the survey of the Engelmann spruce beetle infestation it was found that the attacked lodgepole pine were not at all confined to the vicinity of the Resort but were distributed throughout the stand. Investigation showed that the insects were not Black Hills beetles - that they had the characteristics of the Engelmann spruce beetle. To determine the extent of the infestations in lodgepole pine, 210 sample plots were taken in the area. From the sample plots and additional counts it was determined that 3.5 trees per acre were attacked in 1946 and that 1 tree per acre had been attacked in 1945. The 1946 infestation equaled 6 percent of the lodgepole pine stand. Examinations made on a number of the 1945 attacks proved that nearly all had been pitched out. In fact, only one tree was found in which the attack seemed successful. Because of other species of bark beetle larvae being present it could not be determined if Engelmann spruce beetle larvae had developed.

Although the insect reported as attacking the lodgepole pine has here been called the Engelmann spruce beetle it must be emphasized that there is no definite proof of the species. The lodgepole pine beetle (*D. murrayanae* Hopk.) which attacks lodgepole is practically indistinguishable from the Engelmann spruce beetle. However, evidence is strongly in favor of the spruce beetle because of the great numbers in the area and because of the sudden development of so many attacked trees. And too, the attacks are aggressive and extend much farther up the bole of the tree than is ordinarily found with the lodgepole pine beetle.

It is estimated that between 10,000 - 12,000 lodgepole pine were attacked in the area during 1946.

Engelmann Spruce Beetle Infestation
Pagoda Peak-Ripple Creek Pass Area, T. 1 & 2 N., R. 87, 88, 89 & 90 W.
White River National Forest

	Per Acre	Percent in Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	18.9	20.9	33.0	19
" 1945	36.1	46.0	43.9	16
" 1946	28.7	28.8	20.7	12
Residual Stand	4.9	4.3	2.3	10

Basis of Data: 200 Plots, 2730 Exam. Trees

The above area includes the Engelmann spruce type along the Williams Fork - White River divide between Sand Peak and Lost Lakes Peak. There are about 26 sections affected. No examination has been made of the type in the vicinity of Sleepy Cat Peak farther west but in viewing the area from a distance and in discussing it with District Forest Rangers, the conclusion is that the infestation is equally severe in that area.

Engelmann Spruce Beetle Infestation
Lost Lakes - Sand Lakes, T. 1 & 2 N., R. 87 & 88 W.
White River National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	2.7	2.8	4.6	19
" 1945	6.5	8.5	11.7	19
" 1946	29.5	29.6	37.5	16
Residual Stand	47.5	59.1	46.2	14

Basis of Data: 240 Plots, 4852 Examined Trees

This area includes approximately 50 sections in the head of the East Fork of the Williams River, Bunker Creek, and Trout Creek. The type is continuous with that of Ripple Creek Pass and Trappers Lake which it adjoins. Lodgepole pine is found in admixture with Engelmann spruce in the vicinity of Sand Lake and scattered attacks in the lodgepole pine were recorded.

The infestation in the Engelmann spruce is spotty but severe throughout the area. As it may be noticed from the table much less timber has been destroyed than in other areas reported. However, the rapid increase during the past two years indicates a similar type of infestation that is apparently a year behind the infestation on the Flat Tops.

Engelmann Spruce Beetle Infestation
Crosho Lake - Moody Creek, T. 2 N., R. 36 W.
White River National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	.4	1.0	.6	14
" 1945	.1	.2	.2	16
" 1946	1.3	2.1	2.3	17
Residual Stand	77.4	96.7	96.9	14
Basis of Data: 70 Plots, 1033 Exam. Trees				

All of the Engelmann spruce type in the various forks of Hunt Creek and in Watson, Moody, and the East Coal Creeks are included in this area of about 15 sections.

It is in this area that the Engelmann spruce type of the White River Forest has a chance of survival. Until 1945 no more than a normal infestation was recorded. A rather thorough survey was made early in 1945, before the 1945 attack period. Data taken at that time proved that only .7 percent of the stand had been killed during the two years previous. Old snags indicated that the timber had been killed in about the same proportion for a long time.

During the survey of 1946, records show a decided increase but still a comparatively low infestation. The data also show that .2 percent were attacked late in 1945. However, an examination of the stand disclosed that several spot infestations had occurred - apparently flights into the area from the west. These spot infestations are widely scattered throughout the area and may contain up to 100 infested trees. Woodpecker work was very thorough in these groups. Spots of infestation again occurred in 1946 on a larger scale. It is felt that this infestation is largely from flights of insects coming off the Flat Tops and that it will continue for two more years. If the area should by chance escape heavy flights it is possible that woodpeckers and natural agencies may affect a control of the infestation.

Bear River - T. 1 N., R. 86, 87 W.

An examination of the somewhat scattered spruce stands in the Bear River drainage above Coal Creek indicated a serious infestation in the Engelmann spruce stands in the head of the drainage. This area includes about 4 sections in the vicinity of Stillwater Reservoir. A check of the stand showed that 5 percent of the larger trees had been killed in 1945 and 10.8 percent in 1946. The younger stands along the south side of Bear River between the reservoir and the Bear River R. S. are not seriously infested.

Derby Creek - T. 2 S., R. 86, 87 W.

While no examination was made in the Derby Creek drainages in 1946, it is felt advisable to point out that serious infestations were reported in 1944 and again in 1945. There is little doubt but that it continues strong.

Summary of Losses on the White River National Forest

In summing up the losses that have occurred on the White River Forest, the writer must confess a desire to leave the application of the loss figures to someone more familiar with stand volumes. However, it is felt that no one else has had the opportunity to examine so many parts of the forest with the single purpose of analyzing the insect damage. So, with the knowledge of certain small or sizeable areas here and there in the forest - perhaps more moderately infested than others, the data for the separate areas has been tempered and rounded out, and applied to the working circle volumes to give the following estimate of loss:

<u>Working Circle</u>	<u>Volume M. Ft., B. M</u>	<u>% Loss</u>	<u>Loss</u>
			<u>Volume, M. Ft., B. M.</u>
Bear River	298,304	15	44,746
Colorado River	449,073	98	440,092
Dotsero	386,730	95	367,393
White River	1,273,310	95	1,209,644
Williams River	525,456	40	210,182
	<u>2,932,873</u>	<u>77.5</u>	<u>2,272,057</u>

HOLY CROSS ADDITION, WHITE RIVER NATIONAL FOREST

Surveys and extensive examinations during 1944 and 1945 included all of the important Engelmann spruce stands of the Holy Cross Addition. This earlier work permitted us to limit the 1946 survey to four areas where the infestation was epidemic. It is gratifying to note that substantial decreases occurred in all four areas.

New York Mountain and Iron Ridge, near Yeoman Park are only slightly separated. Of the two, Iron Ridge has the heaviest infestation.

Engelmann Spruce Beetle Infestation
Iron Ridge Area, T. 6 & 7 S., R. 83 W.
Holy Cross Addition White River National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	10.0	3.7	18.7	25
" 1945	14.0	4.1	13.7	18
" 1946	4.3	1.9	2.0	13
Residual Stand	84.7	90.3	65.6	17

Basis of Data: 30 Plots, 2100 Exam. Trees

A part of the Iron Ridge infestation was examined late in 1945. At that time it was possible to get only a small amount of data which proved to be from one of the more heavily infested spots. However, the data did show that the infestation was at that time increasing.

During 1946 the size of the area was determined to be about six sections. The Engelmann spruce type is very indefinite, occurring in long stringers along the ridges and often mixed with lodgepole pine and alpine fir. All of the heavy spots of infestation in this area are directly associated with windfalls which occur along the ridge tops. Apparently, the peak of this infestation was reached in 1945. The decline during 1946 is general throughout the area.

Engelmann Spruce Beetle Infestation
New York Mountain Area, T. 6 S., R. 82 & 83 W.
Holy Cross Addition, White River National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	3.6	4	8.6	22
" 1945	5.7	3	12.0	21
" 1946	2.7	1	5.4	20
Residual Stand	79.6	92	70.0	14

Basis of Data: 70 Plots, 3561 Exam. Trees

The area described as New York Mountain covers approximately 7 sections in the heads of East Nolan, Squaw, and West Lake Creeks. The type here is similar to that in the Iron Ridge area, being composed of scattered patches and stringers of Engelmann spruce interspersed with lodgepole pine and alpine fir. The infestation is very spotty and mostly confined to areas along ridge tops. The decrease that occurred during 1946 was nearly comparable to the decrease on Iron Ridge.

Woody Creek Area, T. 9 S., R. 83, 84 W.

This area covers 6 sections in the head of Spruce creek, Silver creek and Woody creek. More investigative work has been undertaken in the Woody creek district than in other areas of the Holy Cross largely because of its economic importance. The status and distribution of the Engelmann spruce beetle infestation is therefore better known in this area than in other localities. However, due to unfavorable circumstances during the survey of 1946, very little data were secured. The information obtained did show a reduction during 1946 of approximately 50 percent. A subsequent examination by the writer indicated that the data (20 plots) seemed to be a fair sample of the trend because a check of 155, 1945 and 1946 attacked trees showed the ratio of 1945 to 1946 attacks to be 12 to 5. Because the data obtained in 1946 are not sufficient to show the relationship between 1946 and subsequent years, data taken during 1945 based on 967 sample plots are given:

	<u>1943</u>	<u>1944</u>	<u>1945</u>
Attacked Trees per Acre	1.35	6.54	1.69
Percentage of Trees Inf.	1.2	5.7	1.5
Percentage of Basal Area	1.5	8.5	1.7

Here again, the relationship between wind-falls and the subsequent infestation is apparent. In the head of a fork of Silver creek, section 13, T. 9 S., R 83 W., and continuing up the ridge toward Porphyry Mountain is an area of severe wind-throw. Salvage operations were undertaken to save as much of the down timber as possible. This was through a sale to a local operator. Much of the down timber was taken out but not before an infestation developed in the immediate vicinity. Logging continued after the salvage operation and consequently a great many infested trees were logged. Logging and intensive woodpecker activity have no doubt been instrumental in holding the losses to a lower level than could otherwise have been expected.

Engelmann Spruce Beetle Infestation
Thompson Creeks, T. 8 & 9 S., R. 89 W.
Holy Cross Addition, White River National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	1.7	.6	7.0	22
" 1945	1.0	.4	2.9	18
" 1946	.0	.0	.0	0
Residual stand	70.0	99.0	90.1	9
Basis of Data: 30 Plots, 2658 Exam. Trees				

Engelmann spruce type in the heads of the three forks of Thompson creek covers about 20 sections in scattered patches interspersed with numerous open parks and stands of nearly pure alpine fir. Alpine fir constitutes a high proportion of the stand throughout the spruce type, especially on northern exposures.

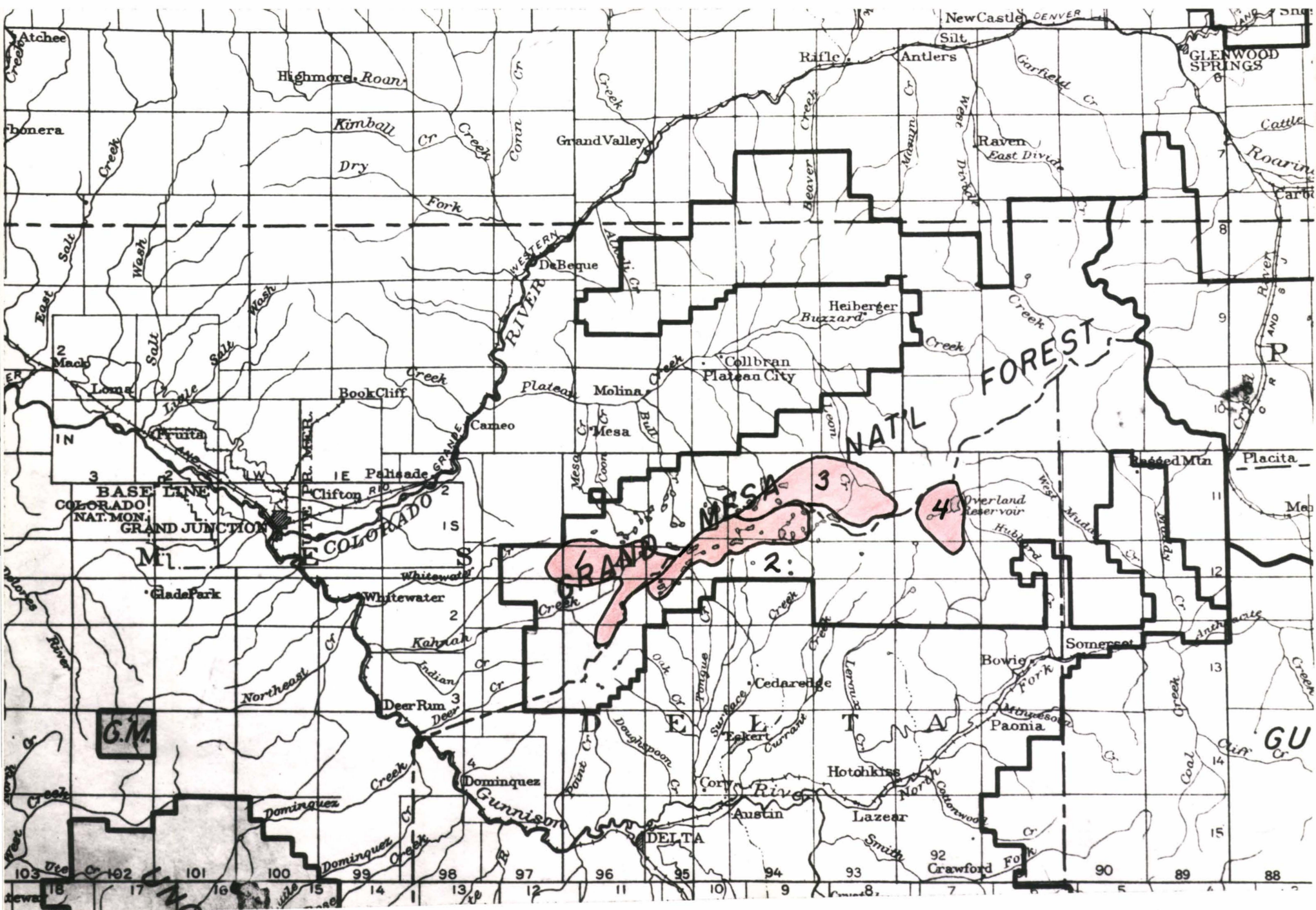
This area was not considered to be seriously infested. However, data taken in 1945 showed that an increase had occurred in the number of infested trees during 1944. The survey during the past season was more in the order of an extensive reconnaissance to check on the present status. The data obtained, although limited, indicated that the infestation had decreased in 1945 and again in 1946. In fact no 1946 attacks were found.

Summary of Losses on Holy Cross Addition

To estimate the losses to the Engelmann spruce stands on the Holy Cross Addition since the start of the present outbreak is a very difficult task because of the indefinite and scattered nature of the stands. Volume tables from the Office of Timber Management show an estimate of 1,408,008 M. ft. b.m. on the forest. Approximately half of that volume is within the areas or adjacent to the Woody Cr.-Iron Ridge-New York Mt. areas. A rough estimate of the losses in these areas since the start of the outbreak is 10 percent of the volume or 70,000 M. ft., b.m. Some of this loss has of course been offset by the logging of infested trees but this has been possible only to a limited extent. As to the future of this infestation, we can only say that at present the indications are that further decreases are probable.

GRAND MESA NATIONAL FOREST

- 1. Indian Point - Lands End**
- 2. Ward Lake**
- 3. Leon Creek**
- 4. Muddy Creek**



GRAND MESA NATIONAL FOREST

A survey was made of the greater portion of the Grand Mesa National Forest during July of 1945. While this survey did provide information relative to the extent of the infestation and gave an indication of the losses through 1944, the work was completed before the 1945 attack period. Because of the limited field season and funds, no data as to the status of the 1945 attacks were obtained.

During the past season a survey was made of three areas on the forest, the western end which includes Indian Point and Lands End, Ward Lake area - Indian Point to Trickle Park, and Leon Creek drainage. Plans of the survey included the Muddy drainage but, unfortunately weather conditions did not permit the plan to be carried out.

Engelmann Spruce Beetle Infestation
Indian Point - Lands End, T. 12, 13 S., R. 95, 96 W.
Grand Mesa National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	6.0	5.1	6.4	20
" 1945	10.4	8.8	13.7	16
" 1946	17.9	15.2	16.5	14
Residual Stand	83.2	70.9	63.4	13

Basis of Data: 220 Plots

The infestation is building up rapidly in the Indian Point - Lands End area which includes all of the mesa top west of State Highway 65 - about 25 sections. This area is typical of flat mesa-like terrain, with many open parks and densely timbered "islands." Approximately 50 percent of the area is timbered with rather short trees of apparently good vigor. Because of the exposed site, this area suffered badly from the high wind during 1939. Some areas are practically blocked with windfalls. The stand becomes progressively scrubby farther east as the altitude increases. East of Highway 65 the stand deteriorates to a sparsely stocked, scrubby type mixed with aspen. Very little infestation is found in this latter area.

There seems to be little hope for the timber on the Indian Point or Lands End mesas. The Engelmann spruce beetle population is very high. Broods within the attacked trees are extremely heavy; numbering in many instances over four hundred adults to the square foot of bark.

Engelmann Spruce Beetle Infestation
Ward Lake Area, T. 11, 12, 13 S., R. 94, 95 W.
Grand Mesa National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	5.2	6.1	8.4	15
" 1945	3.1	3.7	3.2	15
" 1946	3.4	4.0	3.8	14
Residual Stand	73.0	86.2	84.6	12
Basis of Data: 190 Plots				

The Ward Lake area may be described as extending along the south side of the Grand Mesa from Battlement Lakes to Leon Peak in a narrow belt approximately two miles wide. Of the 23 sections about half the acreages is either lake or rock slides. There are also a few open parks.

While the infestation has been active in the Ward Lake area for as long a period as in other parts of the forest, it has been possible to log a great many of the infested trees through small timber sales. Where such sales have been possible, nearly all of the infested timber has been salvaged and the infestation has been held in partial check. This result is reflected in the tale of losses for the district.

Engelmann Spruce Beetle Infestation
Leon Creek Drainage, T. 11 S., R. 93, 94 W.
Grand Mesa National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	6.6	8.2	16.0	17
" 1945	5.5	6.8	10.4	15
" 1946	7.2	8.9	6.4	12
Residual Stand	61.4	76.1	67.2	12
Basis of Data: 240 Plots				

This area covers approximately 30 sections and extends from the Big Creek road to the head of Leon Creek. The type is rather young Engelmann spruce that is quite heavily mixed with alpine fir. There are numerous large open parks, which to some extent, separate the timber into individual stands. Steep northern slopes run largely to alpine fir. Engelmann spruce, however, is more abundant on the bench like flats. The Engelmann spruce beetle infestation is much more pronounced in the stands having a larger proportion of spruce. Old windfalls

are quite evident on the higher ridges and exposed localities. In the vicinity of Lambert reservoir there are numerous windfalls of more recent origin.

Muddy Drainage, T. 11, 12 S., R. 92 W.

No data relative to the infestation in the Engelmann spruce stands of the Muddy Creek drainage are available for the past two years. A reconnaissance made during July of 1945 did not include the 1945 attacked period which was just starting at the time. However, small areas of 1944 infestation were found in the vicinity of Overland reservoir but the infestation did not at that time seem very serious. As to what has happened since we can only speculate. The 1944 infestation equaled 1 percent of the stand. If the ratio of increase is similar to the increase in the Leon Creek drainage which is adjacent to the north west, the 1946 infestation would be about 3 percent of the stand.

Summary of Losses on the Grand Mesa Forest

To draw conclusions as to the infestation on the Grand Mesa National Forest, data now available from 660 sample plots indicate a $23\frac{1}{2}$ percent kill during the present epidemic. In volume it is considerably more. Combined data from the three areas surveyed show the percent of basal area killed to be 30.6.

Timber management tables show an estimated 263,833,000 ft. b.m. of Engelmann spruce on the forest. Of this volume then, over 80 million board feet has been attacked and killed by the Engelmann spruce beetle.

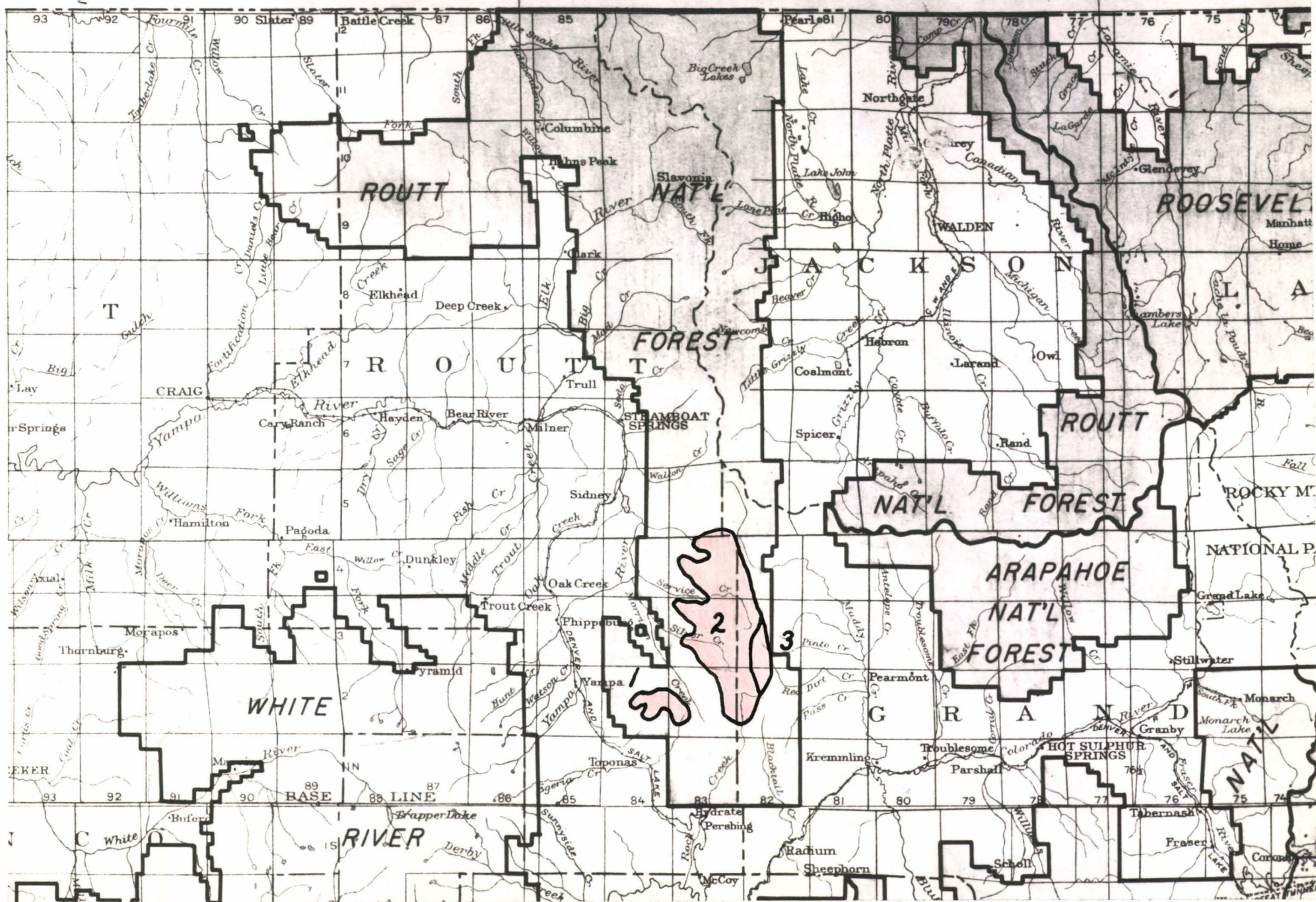
As to the future of this infestation, there seems to be little chance that the epidemic will subside. Nearly all the spruce on the mesa top will perhaps be attacked. Removing infested trees through sales on the Ward Lake district may prevent the entire loss of the timber or retard the infestation. However, the end result may be a depleted stand.

In the Leon drainage the losses will no doubt continue heavy. Some survival can perhaps be expected where the Engelmann spruce is heavily mixed with alpine fir. For some reason attacked trees are not so prevalent in such mixtures.

BOUNT NATIONAL FOREST

1. Wheeler Basin
2. Western side of the Gore Range
3. Red Dirt Creek

N



ROUTT NATIONAL FOREST

Several serious infestations of the Engelmann spruce beetle developed on the southern end of the Routt National Forest. These infestations built up at the same time as the outbreak on the White River Forest and under the same circumstances. The first indication of an epidemic appeared in the Wheeler Basin area where insect killed trees were encountered in 1944 while marking trees for timber sale. An aerial reconnaissance over the area and the adjacent Gore Range proved the infestation to be prevalent throughout the Wheeler Basin stands and to be pretty well distributed along the west side of Gore Range.

Wheeler Basin and the western side of the Gore Range were in the path of the 1939 windstorm. Windfalls, as a result, are rather common in spots throughout the areas. There are no large areas of windfalls such as are found on the White River and Grand Mesa National Forest but there are numerous areas on south western slopes and along ridge tops where a surprising number of trees went down.

Virtually all of the infested Engelmann spruce stands are south of U. S. Highway 40 and extend down the Gore Range in more or less isolated patches in the heads of the side drainages to State Highway 84. As nearly as can be estimated there are 30 sections of Engelmann spruce type in this area on which Timber Management tables show a volume of approximately 93 million board feet. Wheeler Basin and Toponas Creek contained an additional 5 3/4 million feet - Red Dirt, Muddy, and Pass Creeks, 86 million; a total volume of over 184 million board feet.

Wheeler Basin, T. 2 N., R. 83, 84 W.

Extensive examinations later in 1944 proved that between 71 and 90 percent of the Engelmann spruce in the Wheeler Basin was infested. During 1945 an additional 13 percent of the residual stand was attacked and the infestation decreased rapidly from the lack of host material. Although nearly all of the timber in this area was killed, logging operations harvested most of the timber so it cannot be considered as lost.

Gore Range, T. 2, 3, 4 N., R. 82, 83 W.

A reconnaissance along the western side of the Gore Range during 1945 provided information that gave a more complete picture of the type of stands and of the infestation. It was found that much of the timber is near the southern end of the range in the heads of Rock Creek, Morrison Creek, Service and Silver Creeks; that farther north the spruce type is more patchy and scattered. Data taken as to the ratio of green and insect killed trees showed that the infestation varied from 13 percent of the stand in the southern drainages to 56 percent farther north. At that time there was evidence of a decline in the infestation. Trees attacked in 1945 were not as numerous as 1944 attacks. However, because of the still high insect population optimism was not felt to be justified. Additional data taken by a survey crew in 1946 showed a further decrease of nearly 30 percent. The 1946 attack was 4 percent of the residual stand which brings the total kill by the Engelmann spruce beetle to 17 percent. This figure is applicable to the 93 million board feet along the western side of the Gore Range and amounts to 15.8 million ft., b.m.

Examinations of the stands on the eastern side of the Gore Range, in Red Dirt, Pass, and Muddy Creeks have shown these areas to have been relatively free from infestation since 1944 although attacks up to that time killed 7 percent of the stand or nearly 4 million board feet.

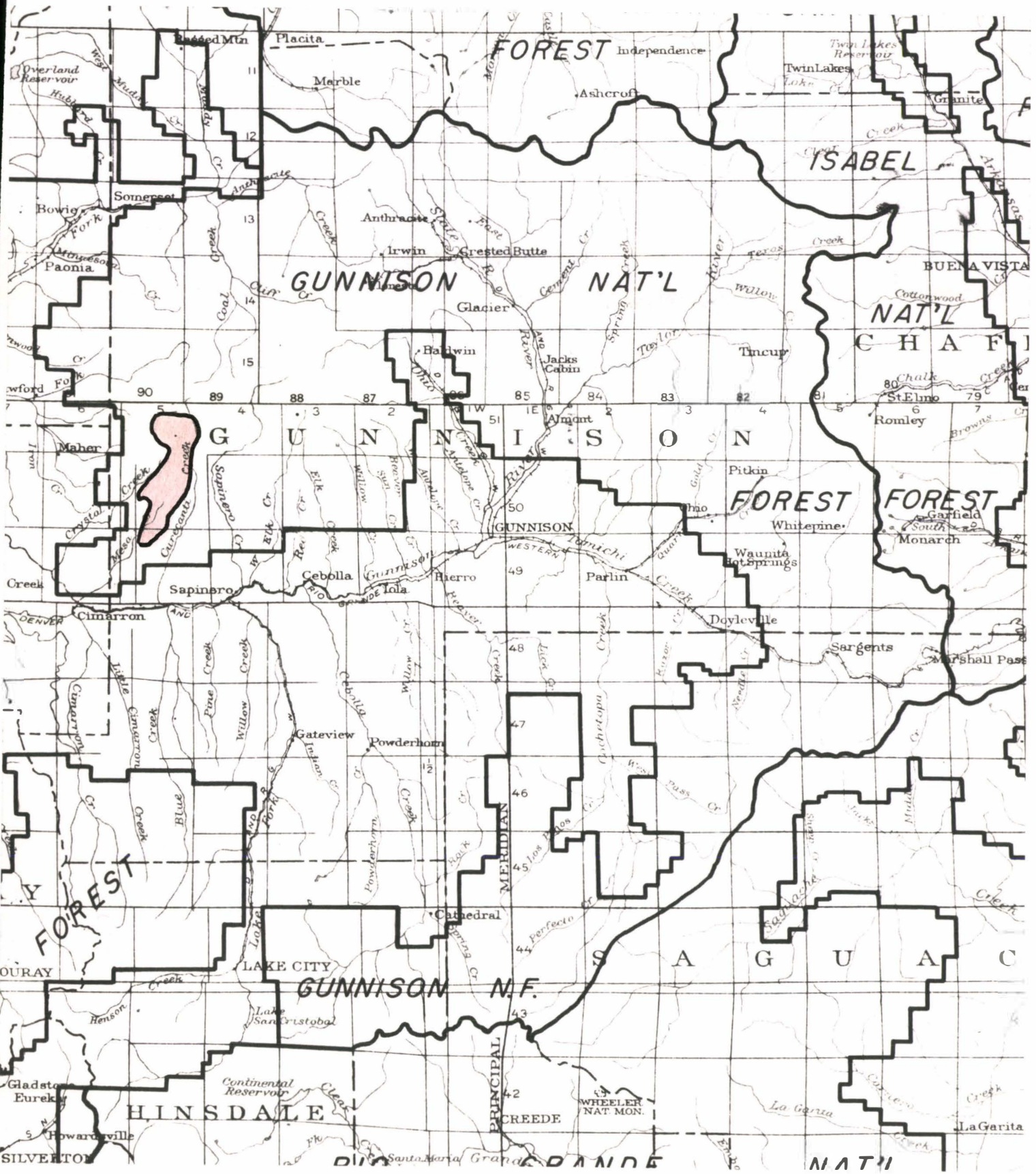
Summary of Losses on the Routt National Forest

To sum up the insect damage to date for all of these areas, approximately 25.3 million board feet has been killed of which about 5 million has either been logged or will perhaps be logged, leaving a loss of over 19 million feet.

There is now some basis for the hope that the critical period has passed - that the damage has been done, and that with the aid of natural controlling factors, the infestation will continue to decrease until a normal balance is reached.

GRANT NATIONAL FOREST

Black Mesa area



Overland Reservoir
Hudson
Rowley
Somerset
Paonia
Crested Butte
Glacier
Baldwin
Jack's Cabin
Almont
Pitkin
Whitepine
Wauneta
Doyleville
Sargents
Marshall Pass
Cathedral
LAKE CITY
Continental Reservoir
Gladstone
Eureka
Howardville
SILVERTON
DOLores
SANTA MARIA
GRAND
DOLores
NAT'L

GUNNISON NATIONAL FOREST

As a result of extensive examinations of nearly all of the Engelmann spruce stands of the Gunnison National Forest during 1944 and 1945, it was determined that the Engelmann spruce beetle infestation was confined to the Black Mesa of the Gunnison and near-by plateaus.

Forest Ranger Read reported the infestation on the Black Mesa where he estimated that 2000 trees had been killed during 1942-1943. This area was inspected by the writer during 1944. The infestation had by that time destroyed about 50 percent of the stand on an area 3 miles long and from a half to a mile wide -- approximately 1400 acres. Very few new attacks were seen in the vicinity of the kill but some 700 new attacks farther south on the mesa were marked. Through a timber sale and control measures, many of these infested trees were cut. However, the work was not completed nor were areas of infestation under the mesa rim along the eastern side treated. A survey of the area during 1945 proved that a sharp decrease had occurred in the infestation both on the controlled area and on adjacent uncontrolled areas.

Results from a recheck of the area again in 1946 shows the infestation to have reached a normal status as indicated in the following table.

Engelmann Spruce Beetle Infestation
Black Mesa, T. 50, 51 N., R. 89, 90 W.
Gunnison National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	10.4	11.4	16.4	15
" 1945	1.6	1.4	2.0	14
" 1946	.2	.1	.2	12
Residual Stand	77.1	87.1	81.4	12

Basis of Data: 100 Plots, 4072 Exam. Trees

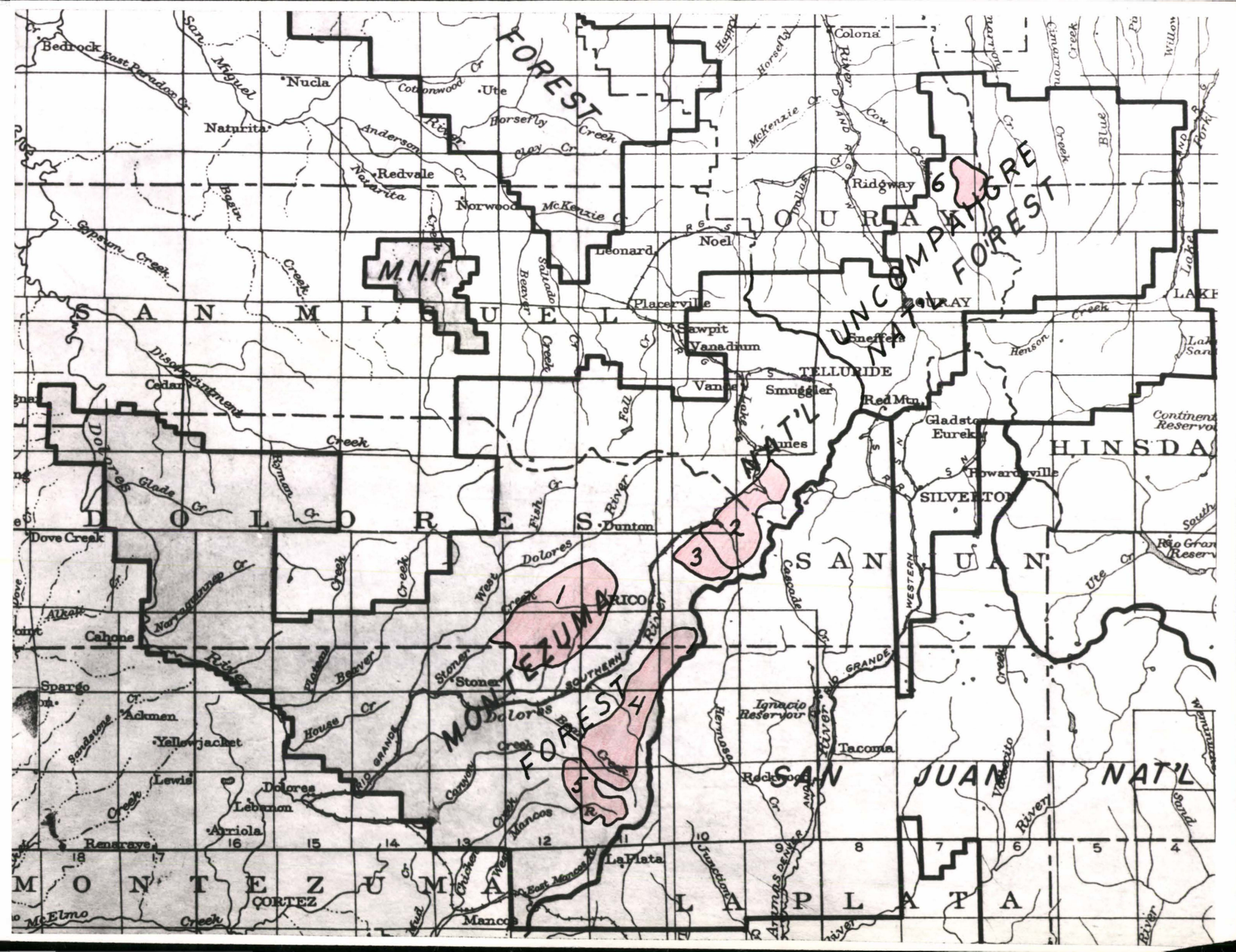
As to the cause of this epidemic infestation, windfalls are again believed to be directly responsible. Windfall areas are located along the mesa top in the original heavy kill. Some spread seems to have occurred down along the mesa top and eastward under the rim. However, this infestation is thought to have reached its peak about 1943. Natural controlling factors abetted by artificial treatment and timber sales are all thought to be instrumental in bringing it under control. An estimate of the losses that occurred during this rather brief epidemic are placed at 7000 trees containing approximately $1\frac{1}{2}$ million board feet.

MONTANA NATIONAL FOREST

1. Stoner Drainage
2. Snow Spar, Twin Creek, and Trout Lake
3. Barlow Creek
4. Bear Creek to Scotch Creek
5. West Fork of Kansas River

UNCOMPAHGRE NATIONAL FOREST

6. Courthouse Mountain - Flume Creek area



MONTEZUMA NATIONAL FOREST

In 1945 word of an outbreak of the Engelmann spruce beetle in the upper Stoner Creek drainage was received from the Forest Service. Time did not permit us to make much of an examination of the area which later proved to be unfortunate. A quotation from the report of the examination is as follows: "An examination made in sections 27-28, T. 40 N., R. 12 W., show a serious infestation in the Engelmann spruce to be of outbreak proportions. Data taken on 12 sample acres showed 2 infested trees per acre in 1945. During 1944 and 1945, 3 percent and 4 percent of the stems were killed - 7 percent for the two years. In one area 25, 1945 attacks were recorded on 7 acres. - The origination of this infestation is believed to be local, from wind-thrown trees which are numerous along the exposed slopes."

The examination and report was made by the writer and lead to the belief that the condition was indicative of the infestation in the Engelmann spruce stand of the Stoner Creek drainage - an area of 13,000 acres with over 80 million board feet of Engelmann spruce.

Apparently the examination was made in one of several small localities of heavy infestation between Hell Canyon and Knight Springs. During the past summer an extensive examination was made by a two man crew in the Engelmann spruce stands of Stoner Creek but farther east. Although quite a number of 1945 attacks were found, no serious areas of infestation such as that reported in 1945 were seen. The data obtained on this reconnaissance are given in the following table.

Engelmann Spruce Beetle Infestation Stoner Creek Drainage, T. 39, 40 N., R. 11, 12 W. Montezuma National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	2.6	2.0	3.9	18
" 1945	1.5	1.3	2.2	18
" 1946	.6	.4	1.1	19
Residual Stand	100.0	96.3	92.8	14

Basis of Data: 140 Plots, 2724 Exam. Trees

Following the Stoner Creek examination a survey was made in Snow Spur and Twin Creeks during which the crew crossed over from the head of Twin Creek and came down Barlow Creek. This reconnaissance was made because a known, heavy infestation has been active in the Barlow drainage for the past few years and it was desirable to know if it extended into Twin Creek. Apparently, it is confined to the ridge south of Barlow Creek where logging operations are now cutting in the infested timber. On this operation the timber markers report, "Nine out of ten of the trees marked are bug killed." The following table will show the results of the survey in Twin and Snow Spur Creeks.

Engelmann Spruce Beetle Infestation
Snow Spur - Twin Creeks, T. 40, 41 N., R. 9, 10 W.
Montezuma National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	2.4	2.5	2.9	16
" 1945	.8	.7	1.1	16
" 1946	.27	.2	.4	16
Residual Stand	113.1	96.6	95.6	13

Basis of Data: 110 Plots, 1685 Exam. Trees

Examinations were made in the Engelmann spruce stands in the heads of the drainages between Bear Creek and Scotch Creek along the divide between the Montezuma and San Juan National Forests. This is known as the Hermosa-Dolores divide and is in many places above timberline. The spruce stands are usually found in pockets or more or less isolated stands in the heads of the drainages and along some of the lower ridges. The intervening ridges between drainages are often barren. Because of the broken, rough type of terrain, areas of wind-thrown trees are common on exposed slopes. Such areas are usually small and often strip-like as though caused by the action of freak winds.

Although there is considerable variation in the intensity of the infestation the overall average is not high. The following table will show a summary of the data taken.

Engelmann Spruce Beetle Infestation
Bear Creek to Scotch Creek, T. 37, 38, 39 N., R. 10, 11 W.
Montezuma National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	5.25	4.0	6.5	16
" 1945	1.75	1.4	2.3	16
" 1946	.25	.2	.3	15
Residual Stand	102.2	94.4	90.9	13

Basis of Data: 120 Plots, 1489 Exam. Trees

West Fork of Mancos River, T. 37 N., R. 11 W.

An examination of an Engelmann spruce stand in a small sale area proved that several hundred trees were infested northeast of the Aspen R. S. Logging operations were in progress at the time and the infested trees were being marked for cutting.

Further examinations in the head of Bob Creek and North Fork Creek disclosed spotty infestations throughout the area in association with small blow-downs. Apparently, windfall areas occur almost annually in this locality and are followed by a local flare-up of Engelmann spruce beetle infestations which are brought under control by woodpeckers. On 10 acres of samples taken along a trail south of Burro Peak, 11, 1946 and 12, 1945 attacks were counted. From appearances of old snags, such an annual loss has occurred for a long time.

Trout Lake T. 41 N., R. 9 W., and Beaver Creek T. 41, 42 N., R. 12 W.

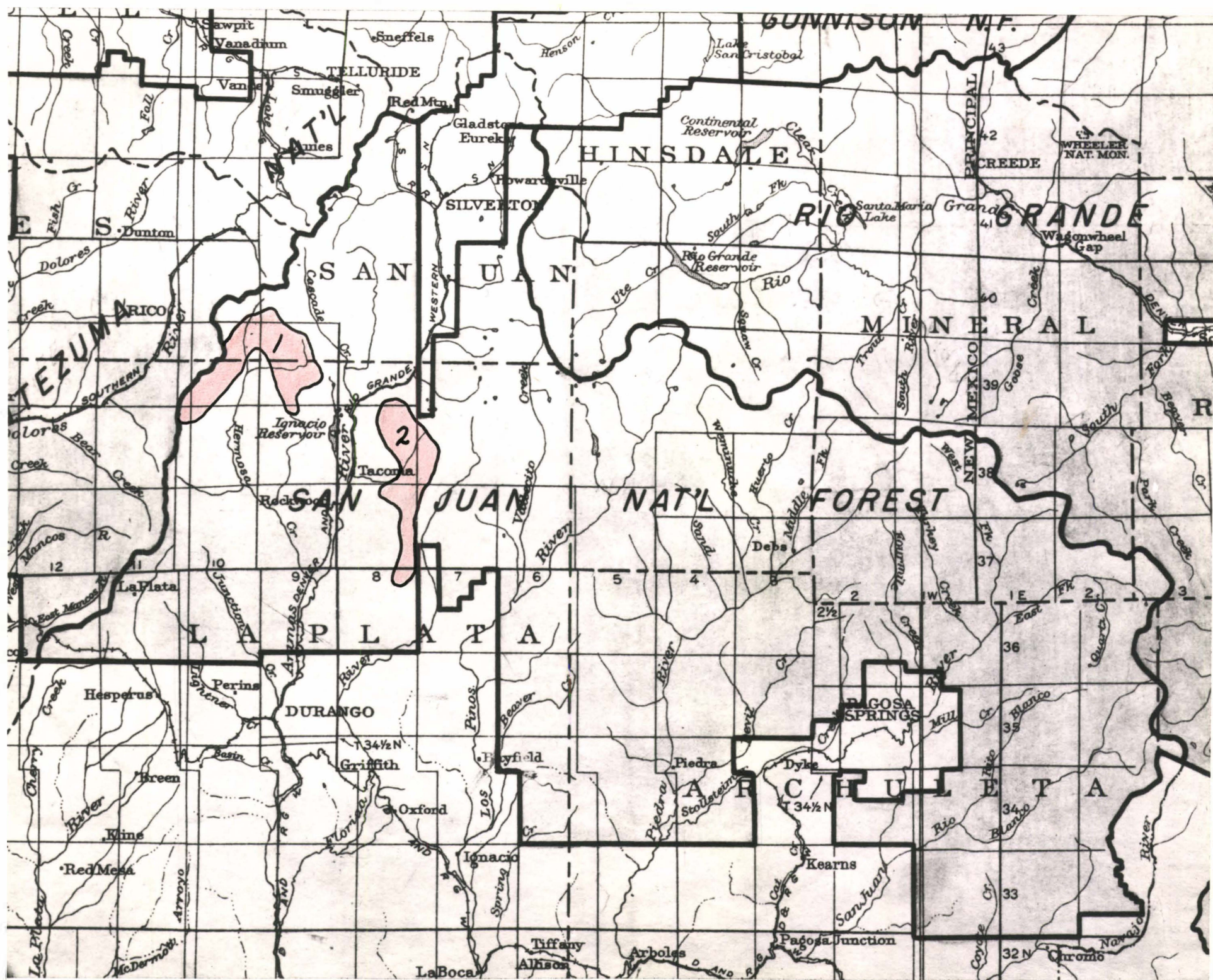
Two additional areas surveyed on the Montezuma Forest included the dense Engelmann spruce stands east of Trout Lake, above Rice and in the head waters of Beaver Creek in the Lone Cone district. No evidence of infestation later than 1944 attacks was found in these areas. Old snags indicate, however, that insect losses have occurred occasionally during past years.

Summary of Losses on the Montezuma National Forest

Although losses have been relatively light on the Montezuma Forest as a whole, it is estimated that, considering the Barlow Creek infestation, approximately 10 percent of the stand has been infested during the past five years. This comparatively low figure adds up to the surprising total of 154 million board feet. There seems to be some basis for optimism regarding the Engelmann spruce beetle infestation for the next few years. However, blow-downs seem to be quite prevalent on the forest and should be watched closely. If they should be at all extensive, a serious outbreak could result.

SAN JUAN NATIONAL FOREST

1. Hermosa drainage
2. Wallace Park - Henderson Lake area



SAN JUAN NATIONAL FOREST

The first indication of an outbreak of the Engelmann spruce beetle in the San Juan National Forest came in 1945 through reports by the Forest Service. Groups of insect killed trees were seen in the Hermosa drainage and in the Henderson Lake area. The only data obtained during 1945 were a series of 48 samples taken in the heaviest spots of infestation by a Forest Guard detailed for a short time to do the work. As samples they were not at all representative of the stand but they did show that there were extensive areas of extremely serious infestation.

A survey of the Hermosa drainage was made during 1946. The data secured are as follows:

Engelmann Spruce Beetle Infestation Hermosa Drainage, T. 38, 39 N., R. 9, 10 W. San Juan National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	4.8	5.0	6.7	17
" 1945	1.8	2.2	2.4	17
" 1946	.2	.1	.4	19
Residual Stand	103.5	92.7	90.5	14

Basis of Data: 130 Plots, 4058 Exam. Trees

The heavy areas of infestation discovered in 1945 were re-examined and additional data were taken throughout the Engelmann spruce stands of the drainage. The peak of this outbreak evidently occurred during 1944 or 1945. The decrease recorded in 1946 indicates a return toward normal after a brief but highly epidemic outbreak. The areas of severe kill are all along the high Hermosa-Dolores divide in the heads of Big Bend, Lone Spruce, and Corral Creeks. In these areas nearly all of the mature Engelmann spruce has been killed. The infested strip extends from 1/2 to a mile below the divide and ends rather abruptly. Similar spots of heavy kill have occurred in the heads of Relay and Sig Creeks, south of Grey Rock Peak. This infestation is mainly on the southern slopes. In addition to the samples taken in the Hermosa drainage a few sample plots were taken on the Animas River slope in the Elbert drainage. No 1946 infestation was recorded and the older kill was very light.

Engelmann Spruce Beetle Infestation
Wallace Park - Henderson Lake, T. 37, 38 N., R. 7, 8 W.
San Juan National Forest

	Per Acre	Percent of Trees	Percent of Basal Area	Diameter in inches of Av. Tree
Killed 1940-1944	1.7	2.3	4.3	20
" 1945	.8	1.5	1.4	17
" 1946	.6	.5	1.3	18
Residual Stand	84.0	95.7	93.0	13
Basis of Data: 250 Plots, 4567 Exam. Trees				

Data obtained in 1945 relative to the Engelmann spruce beetle infestation in the vicinity of Henderson Lake caused considerable concern over the possibility that the infestation might be wide-spread throughout the extensive spruce stands between Horse Thief Park and Tank Mesa. This area has approximately 29 sections of Engelmann spruce type which lies along the top of the Animas-Florida divide. A survey of the area during 1946 proved that there was considerable distribution of the infestation all along the divide where small blow-down areas are common but that the greatest loss had occurred in the vicinity of Henderson Lake and north towards Tank Mesa. The indications are that it was most severe during 1943 and 1944 and has been decreasing rapidly since that time. Very few 1946 attacks were observed except on a small area south east of Henderson Lake.

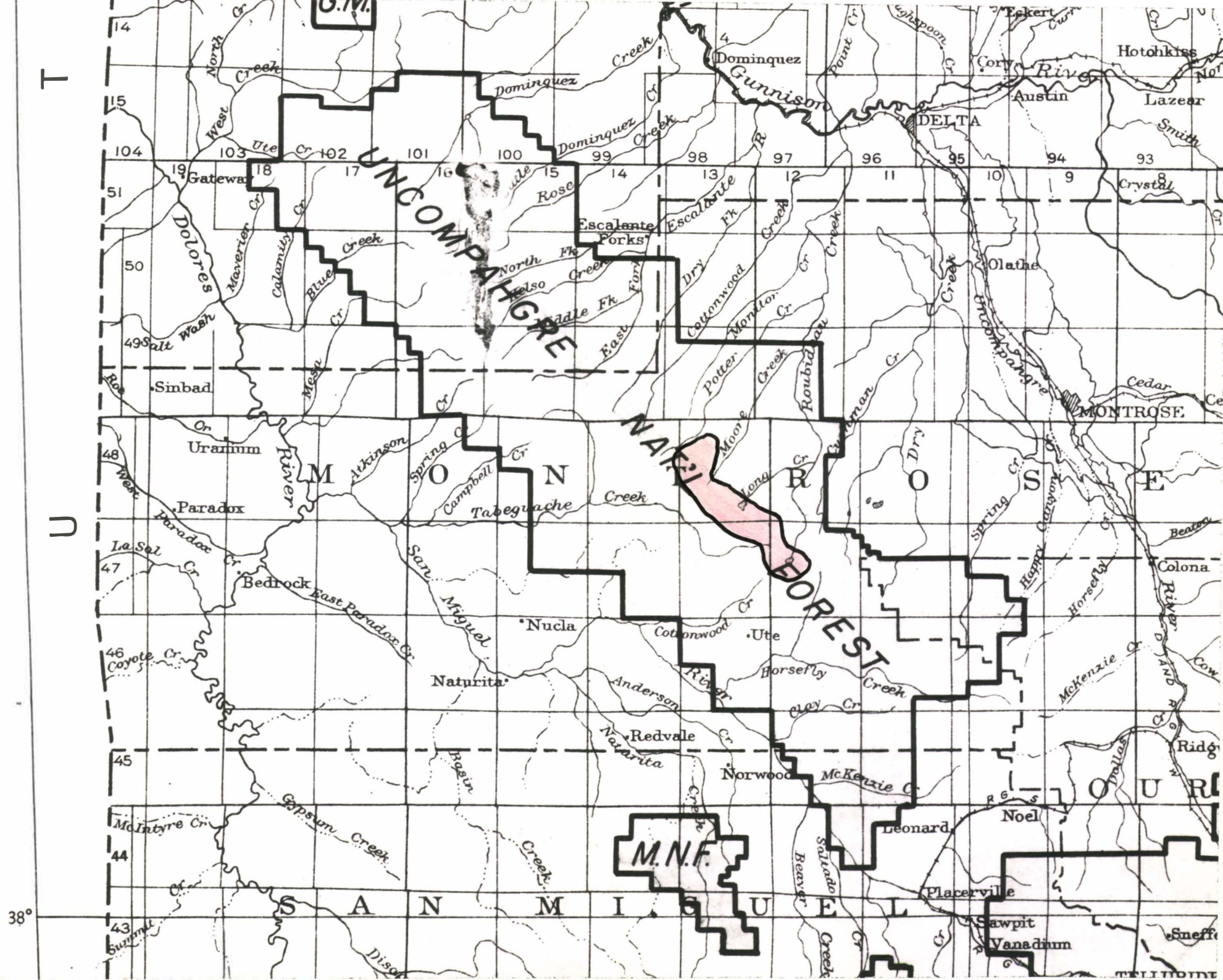
Summary of Losses on the San Juan National Forest

Although it is difficult to estimate the losses that have occurred on the forest during the outbreak, it is believed that the data as recorded in the two tables are substantially correct. While these data are from two separate areas they do indicate that the percentage of loss in each are not far apart. The Hermosa area shows a loss in basal area during the past five years, of 9.5 percent - the Wallace Park-Henderson Lake area 7.0 percent. It may therefore be assumed that approximately 8 percent of the volume has been killed by the Engelmann spruce beetle. This percentage of loss figure is of little value unless applied to the volume in the areas. The volume is, to the writer at least, an unknown quantity and presumably there are no volume estimates broken down to these areas. However, to give, at least an approximation of the losses, in order to prevent a false conception of the damage it is the writers opinion that the loss has been about 50 million ft. b.m. One might say, less than 100 million but over 25 million.

UNCOMPAGRE NATIONAL FOREST

7N Mesa - Darling Lake area

(see Montezuma map for additional Uncompagre infestation)



UNCOMPAHGRE NATIONAL FOREST

The Engelmann spruce stands along the Uncompahgre Plateau have perhaps suffered as much from Engelmann spruce beetle infestations as any other forest. However, much of the infested timber was accessible through access roads and was salvaged. Logging operations still continue and although the Engelmann spruce stands have been seriously depleted, a great deal of it, at least, will have been utilized.

Flume Creek, Owl Creek, and West Fk. Cimarron River, T. 45 N., R. 6, 7 W.

Several areas northeast of Ouray, Colorado, in the vicinity of Courthouse Mountain were examined during this past season. An infestation was reported active in the Flume Creek drainage by the Forest Service in 1945. This report led to the examination of the drainage and other areas in the immediate vicinity. It was found that the outbreak was of a local nature and had reached its peak about 1944. No 1946 attacks were seen in Flume Creek, Owl Creek, or east of the divide in the West Fork of the Cimarron River drainage although 1940-1944 attacked trees were quite evident. The trees attacked in 1945 were relatively few. Woodpecker work was noticeably heavy on the insect killed trees and is probably responsible for the decrease in the infestation.

Conclusion

As stated early in this report, the Engelmann spruce beetle outbreak that has proved so destructive to the Engelmann spruce stand in Western Colorado is believed to have developed in down timber left in the wake of an unusually severe wind storm of June 1939. As a measure of the loss that has occurred the data as given and applied to the limits of our ability show a loss of 2,652,857 M. Ft. b.m. to date. This does not include losses on the Uncompahgre which were largely salvaged nor the losses in many small areas which undoubtedly exist but have escaped detection. It is the writer's opinion that the total volume infested during this outbreak is well over 3 billion board feet.

During the investigation of this outbreak certain characteristics peculiar to Engelmann spruce beetle infestations became evident. As stated before, apparently this insect maintains a comparatively high normal population in Engelmann spruce stands. Brood population per square foot of bark surface has been found to be higher than most other species of the genus Dendroctonus. Under ordinary conditions the occasional infested spruce offers winter food for woodpeckers in the form of insects under the bark. In their work the woodpeckers often strip all but a small portion of the bark off to the snow line. The three or four feet of the bole protected by the snow must produce a high ratio of insects per square foot to maintain a normal population or the insects would disappear. No doubt this is a biological balance that has been established by nature. When windfalls provide protected host material the balance is upset and the resultant infestation spreads into standing trees in greater numbers than woodpeckers can consume. It would seem natural to assume that woodpeckers concentrate in such areas and probably increase because of additional food supply. Such an occurrence would tend to reduce the bark beetle population until it again reached a balance. How

long it would take before such a balance is reached is believed to be in ratio to the size of the area effected. Apparently, such a balance has been achieved in many of the infested areas and is approaching a balance in others. This seems to be especially noticeable in southwestern Colorado on the Montezuma, San Juan and Gunnison Forests where the infested areas vary from a few to several thousand acres. It is also noticeable on the Holy Cross addition, in the Woody Creek drainage, Iron Ridge and West Lake Creek. The Gore range of the Routt National Forest may be another example. As to the almost complete destruction of the stands of the White River, Uncompahgre, the western end of the Grand Mesa Forests, the outbreak was too wide-spread and too severe for the stands to last until natural factors brought about control.

It is the writers conviction that blow-downs are of prime importance in the development of Engelmann spruce beetle outbreaks in the Colorado area and should be watched for and reported. Such blow-downs on a small scale are not at all uncommon. They may vary from numerous scattered individual trees to masses of trees down in a body. Such a windstorm as of June 1939 is, however, unusual. It would be unfortunate indeed, if such a storm should occur again while the Engelmann spruce beetle population is still in many areas epidemic.



Grand Mesa National Forest, August 1944.

G. R. Struble.

Blow-down (1939). Blow-downs like this are to be found along the western slope from the Montezuma Nat. For. in the southern part of Colorado, to the Routt Nat. For. in the north. They vary in size up to several hundred acres.



Montezuma National Forest, August, 1946. T. T. Terrell.

Evidence of an old strip blow-down of about 1900. The young timber, center right, covers a mass of tangled windfalls. Bug killed snags, center left, adjacent to and extending about $\frac{1}{2}$ mile from the blow-down indicate that an Engelmann spruce beetle infestation followed the windstorm and killed hundreds of trees before natural control was restored.



White River Nat'l. For. Sept. 1946, C. L. Massey.
Looking northeast from Blair Mountain to Shingle Peak in the distant center.
Typical Engelmann spruce stands on the White River Flat Tops. All of the
E. spruce within the scope of this picture is over 90 percent infested.



White River Nat'l. For. Sept. 1944, C. L. Massey.
Looking north from Blair Mountain.
Showing typical blow-downs left by the 1939 windstorm.